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**Potkonjak**

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(54) **PARKING FACILITY RESOURCE MANAGEMENT**

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| ***G07B 15/02*** | (2011.01) |
| ***G06Q 30/02*** | (2012.01) |
| ***G06Q 10/06*** | (2012.01) |
| ***G08G 1/14*** | (2006.01) |
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CPC ..... ***G06Q 30/02*** (2013.01); ***G06Q 10/06375*** (2013.01); ***G06Q 30/0284*** (2013.01); ***G08G 1/14*** (2013.01)

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See application file for complete search history.

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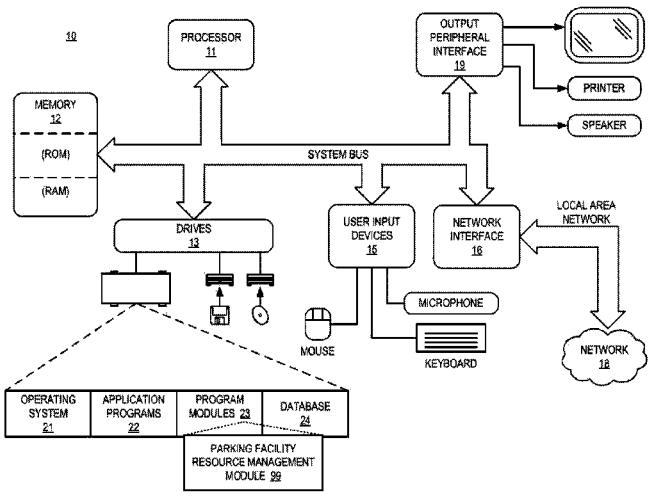
(57) **ABSTRACT**

Technologies are generally described for an information system configured to manage parking facility resources. The system can create and apply models and profiles regarding customers, parking space usage, access patterns, events, traffic, and other factors related to the parking facility. Parking facility operators may use the models to seek optimized revenues or profits. Increased revenue for parking facility operators may be supported by allocating resources to longer staying and better paying customers. New opportunities such as reselling, auctions, or options may further improve revenue generation for parking facilities. Customers may interface with the information system for availability queries, interactive reservation, and various other functions that may improve convenience, security, privacy, and service quality for the customers as well as for neighboring businesses and venues. Improved efficiency in parking facility resource consumption may reduce street traffic congestion. Parking security may be improved by adaptive lighting and camera operation.

**20 Claims, 4 Drawing Sheets**



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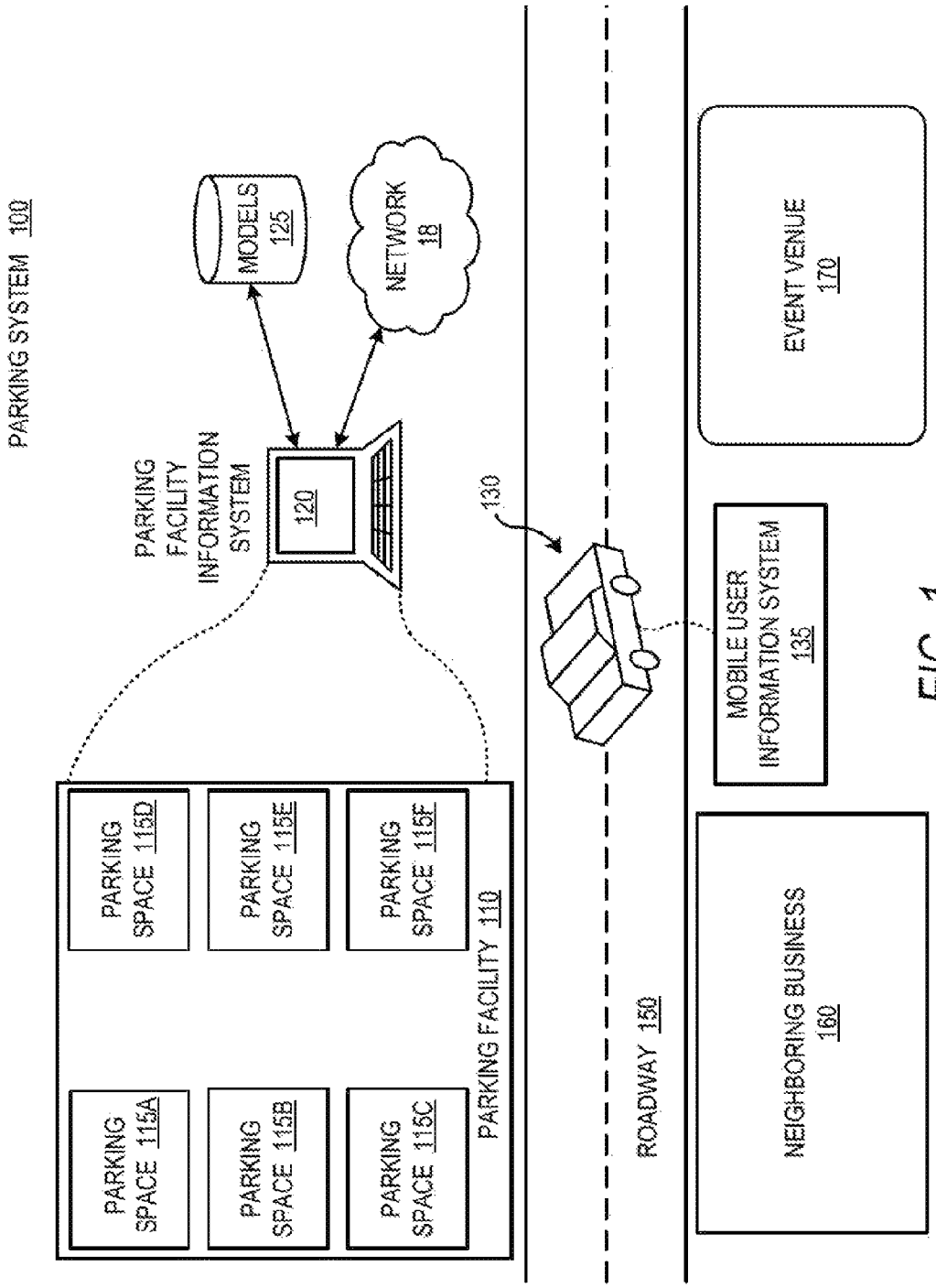
PARKING SYSTEM 100
MODELS 125
NETWORK 18
PARKING FACILITY INFORMATION SYSTEM
120
130
EVENT VENUE 170
MOBILE USER INFORMATION SYSTEM 135
PARKING SPACE 115A
PARKING SPACE 115B
PARKING SPACE 115C
PARKING SPACE 115D
PARKING SPACE 115E
PARKING SPACE 115F
PARKING FACILITY 110
ROADWAY 150
NEIGHBORING BUSINESS 160

FIG. 1

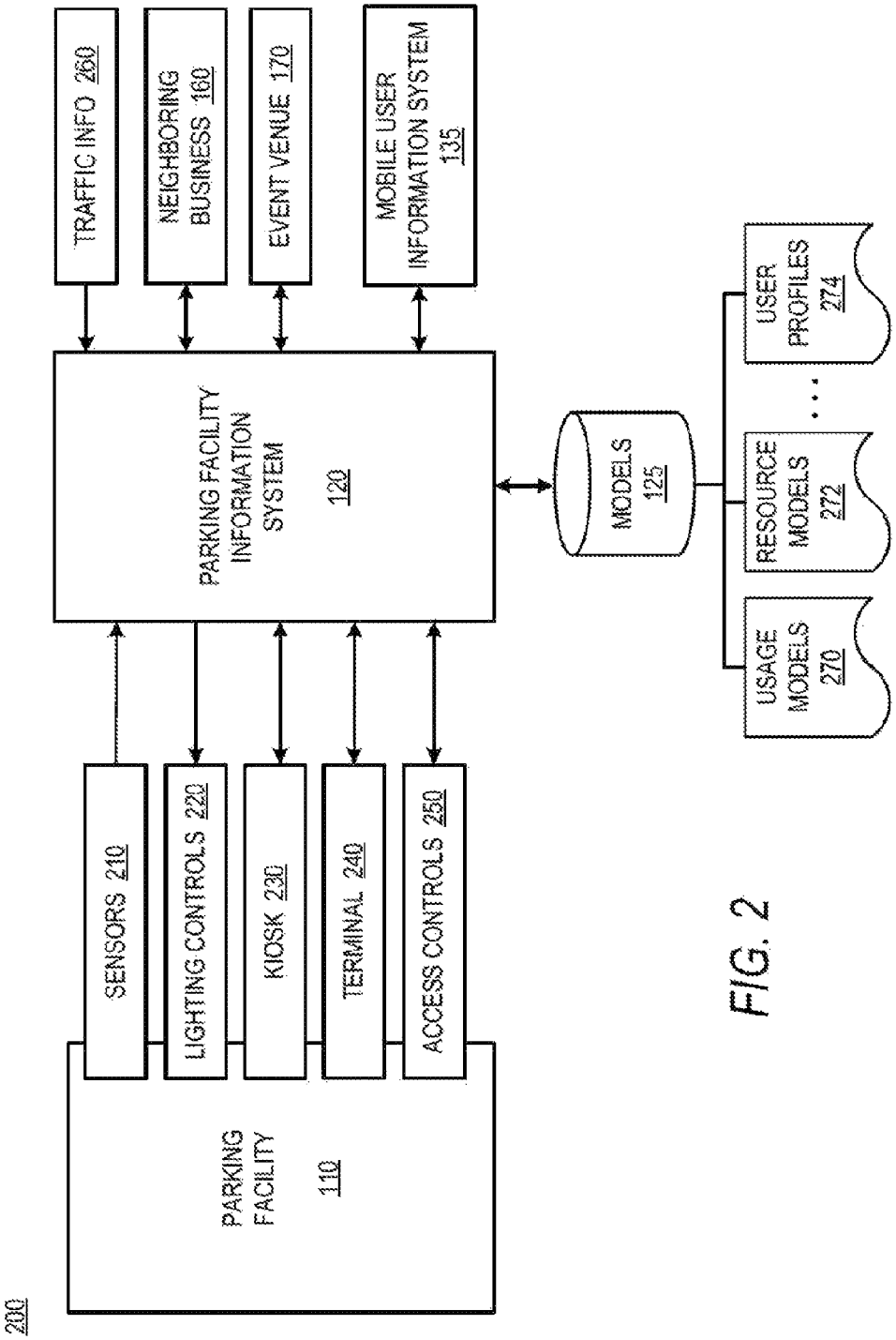
200
PARKING FACILITY 110
SENSORS 210
LIGHTING CONTROLS 220
KIOSK 230
TERMINAL 240
ACCESS CONTROLS 250
PARKING FACILITY INFORMATION SYSTEM 120
TRAFFIC INFO 260
NEIGHBORING BUSINESS 160
EVENT VENUE 170
MOBILE USER INFORMATION SYSTEM 135
MODELS 125
USAGE MODELS 270
RESOURCE MODELS 272
USER PROFILES 274

FIG. 2

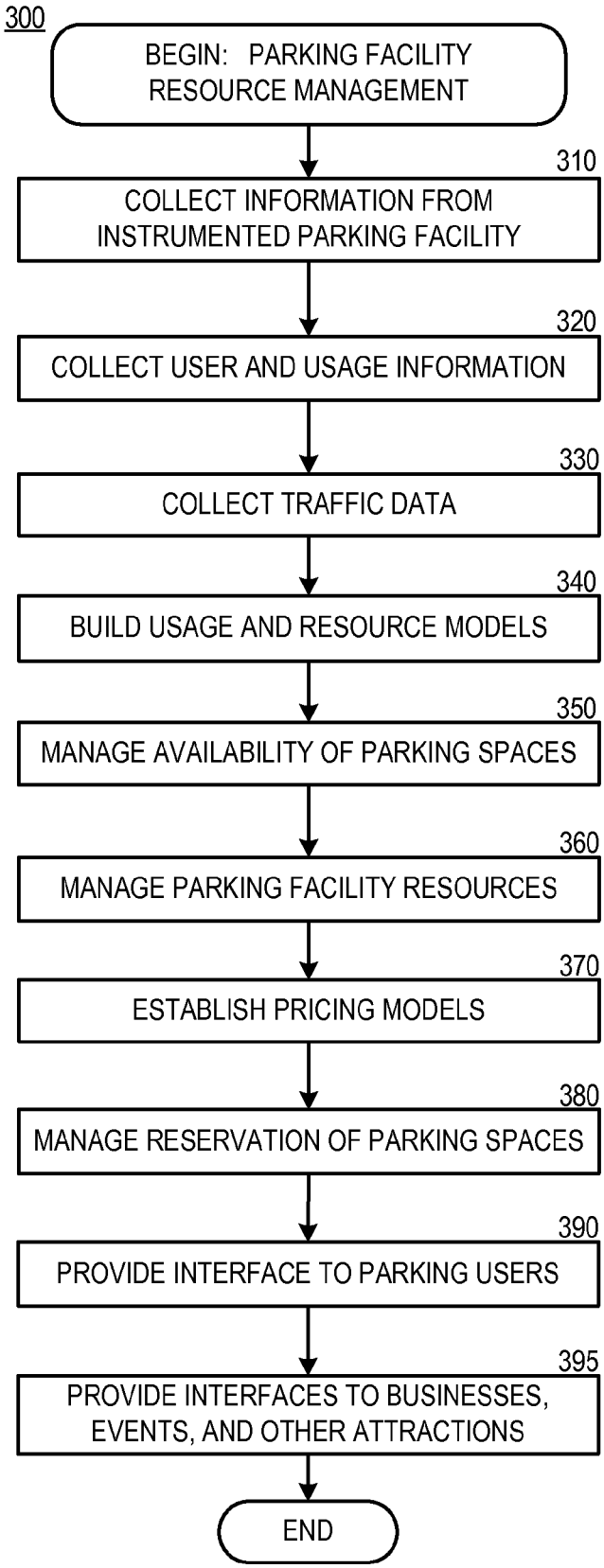
300
BEGIN: PARKING FACILITY RESOURCE MANAGEMENT
310
COLLECT INFORMATION FROM INSTRUMENTED PARKING FACILITY
320
COLLECT USER AND USAGE INFORMATION
330
COLLECT TRAFFIC DATA
340
BUILD USAGE AND RESOURCE MODELS
350
MANAGE AVAILABILITY OF PARKING SPACES
360
MANAGE PARKING FACILITY RESOURCES
370
ESTABLISH PRICING MODELS
380
MANAGE RESERVATION OF PARKING SPACES
390
PROVIDE INTERFACE TO PARKING USERS
395
PROVIDE INTERFACES TO BUSINESSES, EVENTS, AND OTHER ATTRACTIONS
END

FIG. 3

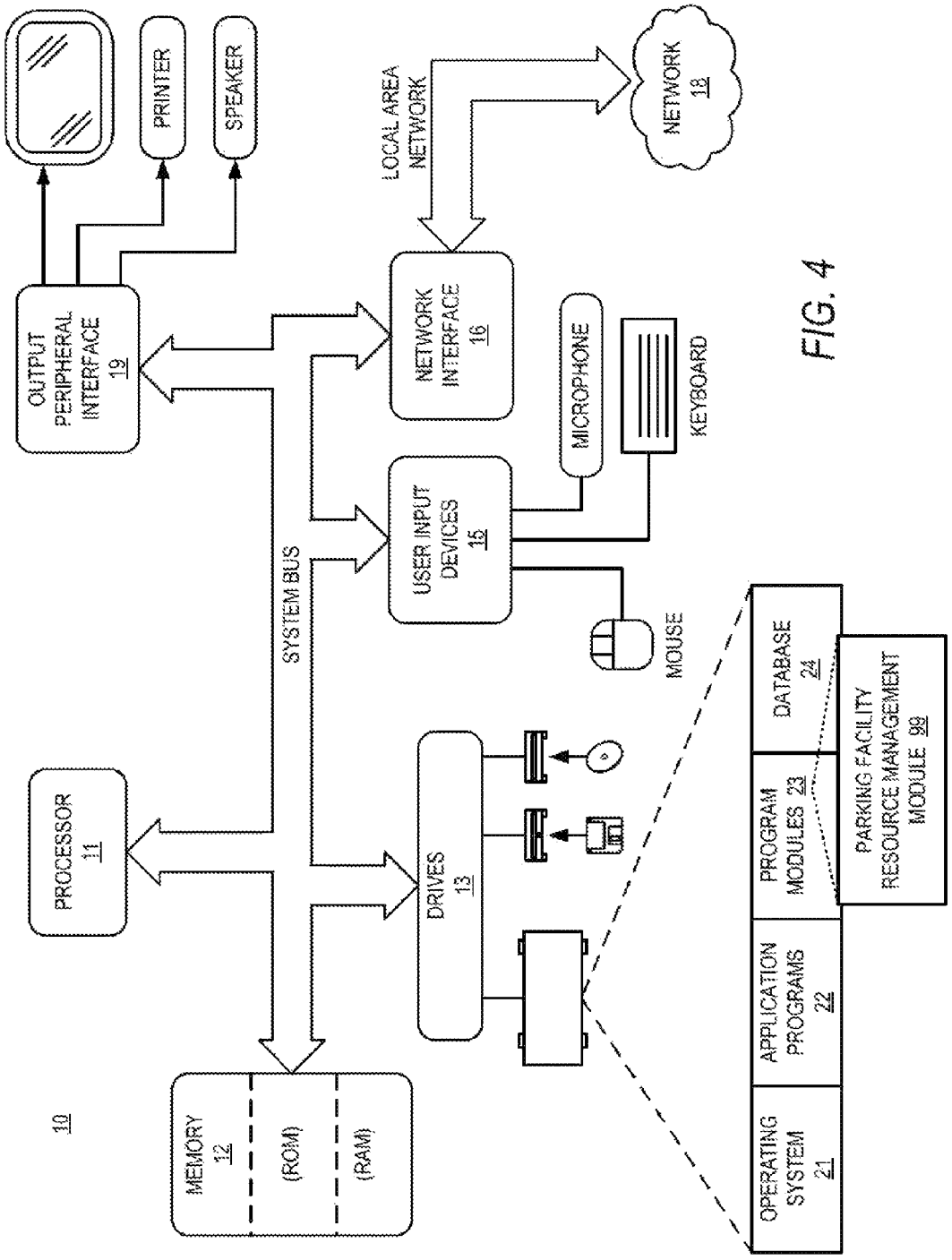
10
PROCESSOR 11
MEMORY 12
(ROM)
(RAM)
SYSTEM BUS
DRIVES 13
USER INPUT DEVICES 15
MOUSE
MICROPHONE
KEYBOARD
NETWORK INTERFACE 16
LOCAL AREA NETWORK
NETWORK 18
OUTPUT PERIPHERAL INTERFACE 19
PRINTER
SPEAKER
OPERATING SYSTEM 21
APPLICATION PROGRAMS 22
PROGRAM MODULES 23
DATABASE 24
PARKING FACILITY RESOURCE MANAGEMENT MODULE 99

FIG. 4

# PARKING FACILITY RESOURCE MANAGEMENT

## BACKGROUND

Parking facilities, such as parking decks and parking lots, can be an important economic resource for the owners and operators of the associated real estate. Parking facilities may also be key allied operations to affiliated or neighboring hotels, hospitals, residential areas, businesses, retail centers, sports venues, event locations, entertainment venues, or other such operations.

For parking customers, full information on the availability and pricing of various parking resources is not readily available. This lack of transparency complicates the market for, and consumption of, parking resources and may result in increased traffic, lost profits, or even avoidance of certain events or locations by consumers. For the managers of parking resources, a lack of detailed information regarding supply, demand, events, traffic, weather, and so on can complicate the establishment of optimal pricing. This can result in further lost profits.

## BRIEF DESCRIPTION OF THE FIGURES

The foregoing and other features of this disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only several embodiments in accordance with the disclosure and are, therefore, not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through use of the accompanying drawings, in which:

FIG. **1** is a block diagram illustrating a parking system with a parking facility and a parking facility information system;

FIG. **2** is a block diagram illustrating a parking facility information system associated with a parking facility;

FIG. **3** is a flow diagram illustrating a process for parking facility resource management; and

FIG. **4** is a block diagram illustrating an exemplary computing system, all arranged according to embodiments presented herein.

## DETAILED DESCRIPTION

In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented herein. It will be readily understood that the present disclosure, as generally described herein, and illustrated in the figures can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly contemplated herein.

This disclosure is drawn to methods, apparatus, systems and computer program products related to information systems associated with parking facility resource management. An information system for managing parking facility resources can support creating and applying models and profiles for customers, space usage, access patterns, events, and other factors related to the parking facility resources. The models can operate in both time-dependent and time-independent regimes. The models may be used to conduct revenue or profit optimization for parking facility operators. Customer coordination, interactive reservation, and other parking facility information system functions may improve convenience, security, privacy, and service quality for customers and neighboring operations. Global positioning system (GPS) technology and wireless communication technology may be used by the parking facility information system. Improved efficiency in parking facility resource consumption may result in reduced street traffic congestion.



Increased revenue for parking facility operators may be supported by allocating resources to longer staying and better paying customers. New opportunities such as reselling, auctions, or options may further improve revenue generation for parking facilities. Parking security may be improved by adaptive lighting and camera operation. These safety operations may be coordinated with mobile phones and GPS technologies. Parking resources may be matched to customer needs to improve various quality of service metrics. Variants of maximum likelihood optimization in presence of uncertainty, or other optimization techniques, may be used to improve the quality of the service metrics. The information system may support organizing parking activities for large events.

Turning now to FIG. **1**, a block diagram illustrates a parking system **100** with a parking facility **110** and a parking facility information system **120** according to one or more embodiments presented herein. A parking facility **110** can be a parking deck, parking lot, parking structure, street parking, distributed parking, any multiplicity thereof, or any combination thereof. The parking facility **110** can include any number of parking spaces **115**A-**115**F. The parking facility **110** may be accessible by a roadway **150**. The roadway **150** may be traveled by vehicles such as automobile **130**, any other automobiles, other vehicles, or any combination thereof. The roadway **150** or area surrounding the roadway **150** may also support neighboring businesses **160**, event venues **170**, or other attractions. These businesses, attractions, and venues may draw parking customers and their automobiles **130** to the parking facility **110**.

The automobile **130** may have an associated mobile user information system **135**. The mobile user information system **135** may be an automobile-based information system, an in-dash information system, a GPS unit, a mobile telephone, a smartphone, a handheld computer, a computer terminal, or any other mechanism for accessing information networks or information systems. One such information system may be the parking facility information system **120**.

The parking facility information system **120** may receive information from instrumentation associated with the parking spaces **115**A-**115**F, access control mechanisms associated with the parking facility **110**, input from an operator associated with the parking facility **110**, or several other possible sources. The parking facility information system **120** may use, construct, or modify various models **125** of resources and usage associated with the parking facility **110**. The models **125** and the related information may be used to simulate and project demand for resources associated with the parking facility **110**. The models **125** may be stored in a database or other storage system associated with the parking facility information system **120**. The parking facility information system **120** may interface to other systems using a network **18**. The network **18** might comprise a wireless data network such as wireless Ethernet, or any mobile telephone or mobile data communication system.

The mobile user information system **135** may interface over the network **18** with the parking facility information system **120**. The parking facility information system **120** may

use information collected from instrumentation associated with the parking facility **110** to construct the models **125**. The models **125** may also use information from users associated with automobiles **130**, users associated with the mobile user information system **135**, along with various other outside information sources. Other outside information may include local street traffic, foot traffic, weather, event schedules, and so forth.

The models **125** may also use information regarding user access demand, as a function of event schedules, day of the week, time of the day, traffic patterns, or various other factors. The models **125** may use supply and demand information may to establish pricing for resources associated with the parking facility **110**. The models **125** may also project and establish availability of parking spaces **115**A-**115**F for given time periods.

The models **125** associated with the parking facility information system **120** may attempt to optimize, or jointly optimize, for metrics related to revenue, profit, safety, efficiency, traffic, or other factors. Such optimization calculations may be conducted using statistical and heuristic techniques. For example, maximum likelihood principles or stochastic programming approaches may be employed. Time-dependent models can support conditional probabilities, such that that a particular scenario may occur a certain number of time units from now in response to another particular scenario occurring currently. The models **125** may be used in cyber-physical simulation techniques to optimize profit or quality of service for various operating scenarios.

Factors making up the models **125** may relate to various entities, or actors, such as customers, events, traffic, and resources. The models **125** can make special allowances for weekends and holidays. The models **125** may support the detection and handling of abandoned automobiles and other vehicles of special interest.

The models **125** may inform the parking facility information system **120** on allocating parking spaces **115**A-**115**F according to a variety of criteria. The allocation criteria may include distance from outside destination, distance from most likely outside destination, congestion elimination, security improvement, and energy expense reduction for lighting, elevators, or other electrical resources.

Location information from GPS, or non-GPS sources may be used by automobiles **130**, drivers, passengers, nearby business employees, parking enforcement employees, security enforcement personnel, car repair services, and other relevant entities or actors. Non-GPS location systems may include sensor networks, location discovery services, mobile phone triangulation, manual location entry, or various other approaches. Cameras, microphones, or various other sensors or detectors may provide inputs to data collection associated with the parking facility information system **120**.

The models **125** may include factors related to neighboring businesses **160**. The neighboring businesses **160** may impact the use of the parking facility **110** or may be impacted by the use of the parking facility **110**. The models **125** may provide information to, or use information from, event venues **170** where customers of the event venues **170** may make use of the parking facility **110**. The models **125** may include information relating to resources or features of the parking facility **110**. These may include parking spaces **115**A-**115**F, elevators, entrances, exits, and so forth.

The models **125** may collect, analyze, estimate, and project information about customers, usage, and demand. The models **125** may seek to optimize, or substantially optimize, a particular set of objectives while satisfying one or more constraints. Information profiles specific to individual customers may also be created and maintained for use by the models **125**. General customer information may include factors for typical, current, and likely near future customers. Customer information may be leveraged to organize and conduct emergency responses associated with the parking facility **110**. Individual customer profiles may include data regarding access times to a particular parking spaces **115**A-**115**F. Customer profiles may also include known or estimated distances from the customer's office, home, or destination.

The parking facility information system **120** may also be used to deliver advertisement information about stores and other neighboring businesses **160** to parking customers or potential customers. One or more instances of the parking facility information system **120** can coordinate management of multiple or remote parking facilities **110**.

The parking facility information system **120** can collect and coordinate various information sources or model **125** outcomes. For example, foot traffic trajectory planning may be used to as an input to pricing and resource allocation. Also, information regarding the parking facility **110** may be combined with other types of information such as the location of a particular seat within a stadium, the location of a store, or a facility such as a restroom.

Turning now to FIG. **2**, a block diagram **200** illustrates details of a parking facility information system **120** and an associated parking facility **110** according to some embodiments presented herein. The parking facility information system **120** can support interfaces to various other entities of information sources. These may include sensors **210**, lighting controls **220**, a kiosk **230**, a terminal **240**, access controls **250**, traffic information sources **260**, neighboring businesses **160**, event venues **170**, mobile user information systems **135**, or any other entity that may interact with the parking facility information system **120**.

Sensors **210**, or other instrumentation associated with the parking facility **110**, may provide information about usage and status of parking facility resources to the parking facility information system **120**. The sensors **210** may include electromagnetic or load sensors to determine the usage of each parking space **115**A-**115**F. The sensors **210** may include various other sensors, such as cameras or microphones. The lighting controls **220** associated with the parking facility **110** may receive lighting control commands from the parking facility information system **120**. The lighting controls **220** may dim the lighting in areas of the parking facility **110** where there is little or no activity or usage of parking spaces **115**A-**115**F. The lighting controls **220** may also increase illumination at parking spaces **115**A-**115**F in response to those parking space resources being offered to or reserved by an automobile **130** entering the parking facility **110**. As such, the lighting controls **220** may operate lights within the parking facility **110** so as to direct customers to specific parking facility resources.

A kiosk **230**, or similar terminal, may be provided in association with the parking facility **110** for reservation of parking spaces **115**A-**115**F or for payment of parking spaces **115**A-**115**F. Such a kiosk **230** may interface with the parking facility information system **120** to provide information related to the users and usage of the parking facility **110**. An operator associated with the parking facility **110** may have an operator terminal **240** for entering and receiving information from the parking facility information system **120**. Access control mechanisms **250** associated with the parking facility **110** may also interface to the parking facility information system **120**. Access control mechanisms **250** may provide information regarding entry or exit into the parking facility **110** to the parking facility information system **120**. An access control module **250** may also request information from the parking

facility information system **120** regarding accessibility, lists, or access control policies to be established with regard to the parking facility **110**.

The parking facility information system **120** may build, employ, or update various usage, pricing, traffic, and other models **125**. The models **125** may be stored in a database or any other information storage mechanism. The models **125** may support usage models **270**, resource models **272**, user profiles **274**, and various other models, simulations, and datasets related to the resources and use of the parking facility **110**. The parking facility information system **120** may receive information regarding local traffic **260**. The traffic information **260** may include both foot traffic and vehicle traffic associated with automobiles **130** to determine factors associated with demand for the parking facility **110**. Traffic congestion sensors can provide information for short-term and long-term projections within the parking facility information system **120**. The parking facility information system **120** may create and maintain models **125** for local weather. Weather related information may be related or correlated with other models **125** for parking usage, traffic, or pricing. Weather related information may be obtained from a provider of such data.

An interface may be provided within the parking facility information system **120** for neighboring businesses **160** to provide information regarding events or high volume traffic expectations. The parking facility information system **120** can coordinate this information with its pricing and resource management models **125**. For example, prices may be increased prior to a special event at a neighboring business **160**. Similarly, an event venue **170** may use an interface provided by parking facility information system **120** to inform the parking facility information system **120** of events. The parking facility information system **120** may use information regarding upcoming events to reserve resources within the parking facility **110**. The parking facility information system **120** may also use information regarding upcoming events to establish favorable pricing for parking spaces **115**A-**115**F within the parking facility **110**.

As discussed briefly above, the parking facility information system **120** may interface with a mobile user information system **135**. The mobile user information system **135** may be used similarly to the kiosk **230** to check for available parking spaces **115**A-**115**F, reserved parking spaces **115**A-**115**F, pay for the use of parking spaces **115**A-**115**F, or to perform other parking facility related tasks. The mobile user information system **135** may also be used to request assistance or emergency service via the parking facility information system **120**. The mobile user information system **135** may be associated with a GPS, or non-GPS, positioning system to inform the parking facility information system **120** on the location of the associated automobile **130**. For example, the parking facility information system **120** may use such location information to reserve or bill for a particular parking space **115**A-**115**F associated with the parking facility **110** based upon location information provided by the mobile user information system **135** and its associated positioning system.

The parking facility information system **120** can maintain specific customer profiles, also known as user profiles **274**. A customer profile may inform a customer model concerning the habits and priorities for that customer. Such a model **125** can provide information about the most likely behavior of the customer under a given scenario. The model **125** may also estimate the probability that the customer will take a particular action under a particular set of conditions that may be measured or calculated. Generalization from the models **125** concerning customers can combine the preferences of all customers or a subset of customers. Customer profile information may be used for congestion management associated with the parking facility **110**. The congestion management may apply inside or outside the parking facility **110**.

Customer information or customer profiles may be analyzed for various system improvements or optimizations. For example, assignment and scheduling operations may use customer information. Stack parking optimization may use customer information. Optimization of long-term parking and other reservations may use customer information. Customer information may inform the optimization of arrival and departure time windows for events. Efficiently organizing matches for car pool may use customer information. Customer information may be used to organize parking reservations and negotiations. Event and long-term parking capacity planning may use customer information. Typical customers, their profiles, and trends in their profiles may be analyzed to allocate resources such as work force, sensing, communication equipment, and lightning. Such allocation may be projected for a certain period or may be made dynamically.

The parking facility information system **120** can support revenue improvement, or maximization, through the creation and application of specific services and contracting opportunities. For example, progressive profile-driven pricing scales may vary as the length of a resource reservation increases. Also, customized contract term renewal policies may be supported. Option contracts may be used to buy or sell a right to park at a specific location or subset of parking spaces. Customers or intermediates may resell parking rights. Auctions may be available for the brokering of parking rights. The winners of auctions may be announced at specific times or continuously. Immediate sales or auctions may support the renting of parking spaces in conjunction with selling one or more other products such as movie theatre tickets or sporting event tickets.

The parking facility information system **120** can support the reservation of parking spaces **115**A-**115**F. Reservation prices may be variable for different types of reservations in terms of duration, certainty, and other relevant parameters. Parking access may be sold where the customer can improve the security level of their vehicle and possessions by requesting addition camera or sensor monitoring. The customer may request additional security using any mobile user information system **135**, such as their mobile telephone.

Referring now to FIG. **3**, additional details will be provided regarding the embodiments presented herein for information systems associated with parking resource management. In particular, FIG. **3** is a flow diagram illustrating a process **300** for parking facility resource management according to at least some embodiments presented herein.

It should be appreciated that the operations described herein are implemented as a sequence of operational or manufacturing acts, as a sequence of computer implemented acts or program modules running on a computing system, or as interconnected machine logic circuits or circuit modules within the computing system. The implementation is a matter of choice dependent on the performance and other requirements of the various embodiments. Some of the logical operations described herein are referred to variously as state operations, structural devices, acts, or modules. These operations, structural devices, acts and modules may be implemented in software, in firmware, in special purpose digital logic, and any combination thereof. It should also be appreciated that more or fewer operations may be performed than shown in the figures and described herein. These operations may also be performed sequentially, in parallel, or in a different order than those described herein.

The process **300** begins at operation **310**, where the parking facility information system **120** can collect information from an instrumented parking facility **110**. As discussed above, the instrumentation associated with the parking facility **110** may include sensors, operator inputs, cameras, GPS location systems, electromagnetic sensors, card readers, proximity sensors, proximity card readers, magnetic strip card readers, any other mechanism for collecting information concerning the access and usage of parking facility **110**, or any combination thereof.

Continuing to operation **320**, the parking facility information system **120** can collect user and usage information. The user and usage information may concern demand, time patterns, and other usage characteristics of the parking facility **110**. User information may be collected into user profiles for specific users. User information may also be aggregated into probabilistic models for typical users or typical users having certain characteristics.

Continuing to operation **330**, the parking facility information system **120** may collect or obtain traffic data. The traffic data may concern the traffic of automobiles **130** on the roadway **150** and other surrounding streets or roadways near the parking facility **110**. The traffic information may also include foot traffic associated with certain times and days, commute times, and events.

Continuing to operation **340**, the parking facility information system **120** may build usage and resource models **125** using data collected in operations **310**, **320**, and **330** as well as other information collected by the parking facility information system **120**. The models **125** may be used to project demand and usage patterns for the parking facility **110** and thus establish pricing models and pricing patterns for the parking facility **110**.

Continuing to operation **350**, the parking facility information system **120** can manage the availability of parking spaces. The parking facility information system **120** can hold parking spaces **115**A-**115**F in reserve or specifically make the parking spaces **115**A-**115**F available. Pricing related to the parking spaces **115**A-**115**F may also be modified based upon usage and resource models associated with the parking facility **110**.

Continuing to operation **360**, the parking facility information system **120** can manage various parking facility resources. Parking facility resources may include lighting, access controls, gates, doors, elevators, stairwells, security systems, fire control systems, terminals, kiosks, payment centers, electronic signage, and any other system or feature associated with the parking facility **110**.

Continuing to operation **370**, the parking facility information system **120** may establish price points and pricing models for the parking spaces **115**A-**115**F within the parking facility **110**. The price points and pricing models may be established by the parking facility information system **120** based upon the models **125** as established in operation **340**. For example, prices may be increased in time periods where one or more of the models **125** project an increase in demand for parking resources.

Continuing to operation **380**, the reservation of parking spaces **115**A-**115**F may be managed by the parking facility information system **120**. Reservation requests may be received by the parking facility information system **120** by any type or number of terminals accessing the parking facility information system **120** over the network **18**. Reservation or reservation requests may also access the parking facility information system **120** from mobile user information systems **135** associated with automobiles **130**. For example, a user may reserve a parking space **115**A-**115**F using a mobile telephone or smart phone.

Continuing to operation **390**, the parking facility information system **120** may provide one or more interfaces to parking users. The provided interface may relate to the mobile user information system **135**, the kiosk **230**, an operator terminal **240**, or any other mechanism for interfacing between a parking user and the parking facility information system **120**. Continuing to operation **395**, the parking facility information system **120** may provide interfaces to businesses, events, or other attractions.

With reference to FIG. **4**, an exemplary computing system is illustrated for implementing various embodiments. The computing system can support embodiments for implementing parking facility resource management. For example, the computing system can comprise a program module **23** such as a parking facility resource management module **99**. Various embodiments may include computers, dedicated hardware, or embedded computing systems. For example, elements of the illustrated computing system may be used as, or embedded into, the parking facility information system **120** or the mobile user information system **135**.

The computing system includes a computer **10**. The computer **10** can include a processor **11**, a memory **12** and one or more drives **13**. The drives **13** and their associated computer storage media can provide storage of computer readable instructions, data structures, program modules **23** and other data for the computer **10**. The computer **10** may be implemented as a conventional computer system, an embedded control computer, a laptop, or a server computer, a mobile device, a set-top box, a kiosk, a vehicular information system, a mobile telephone, a customized machine, or other hardware platform. The processor **11** may be a general purpose processor, a processor core, a multiprocessor, a multi-core processor, a graphics processor, a digital signal processing (DSP) processor, a customized computing device implemented within an application specific integrated circuit (ASIC), a customized computing device implemented within a field programmable gate array (FPGA), a customized computing device implemented within any type of programmable logic, a state machine, a reconfigurable processor, any other processing unit, or any combination or multiplicity thereof.

The drives **13**, other storage devices, or their associated computer-readable storage media can store an operating system **21**, application programs **22**, program modules **23**, and a database **24**. The computer **10** can include user input devices **15** through which a user may enter commands and data. Input devices can include an electronic digitizer, a microphone, a keyboard, a pointing device, or any combination thereof. Examples of pointing devices may include a mouse, trackball, light pen, touch screen, or touch pad. Other input devices to the computer **10** may include a joystick, game pad, satellite dish, scanner, or the like. Input devices can be connected to processor **11** through a user input interface that is coupled to a system bus. The input devices may also be connected by other interface and bus structures, such as a parallel port, game port or a universal serial bus (USB). Computers such as computer **10** may also include other peripheral output devices such as speakers, which may be connected through an output peripheral interface **19** or similar interface.

The computer **10** may operate in a networked environment using logical connections to one or more computers, such as a remote computer connected to network interface **16**. The remote computer may be a personal computer, a server, a router, a network PC, a peer device, or other common network node. The remote computer can include many or all of the

elements described herein relative to the computer **10**. Networking environments may include networks wireless area network (WAN), local area networks (LAN), intranets, the Internet, or combinations thereof.

When used in a LAN or wireless LAN (WLAN) networking environment, the computer **10** may be connected to the LAN through a network interface **16** or a network adapter. When used in a WAN networking environment, the computer **10** can include a modem or other mechanism for establishing communications over the WAN. The WAN may include the Internet, the illustrated network **18**, various other networks, or any combination thereof. It should be appreciated that other mechanisms of establishing a communications link, ring, mesh, bus, cloud, or network between computers may be used.

According to one or more embodiments, computer **10** may be configured such that the processor **11** and/or program modules **23** can perform parking facility resource management in accordance with embodiments presented herein. The computer **10** may include one or more instances of a physical computer-readable storage medium or media associated with drives **13** or other storage devices. The system bus may enable the processor **11** to read code and/or data to/from the computer-readable storage media. The media may represent an apparatus in the form of storage elements that are implemented using any suitable technology, including but not limited to semiconductors, magnetic materials, optical media, electrical storage, electrochemical storage, or any other such storage technology. The media may represent components associated with memory **12**, whether characterized as RAM, ROM, flash, or other types of volatile or nonvolatile memory technology. The media may also represent secondary storage, whether implemented as the storage drives **13** or otherwise. Hard drive implementations may be characterized as solid state, or may include rotating media storing magnetically-encoded information.

The storage media may include one or more program modules **23** such as a parking facility resource management module **99**. The program modules **23** may include software instructions that, when loaded into the processor **11** and executed, transform a general-purpose computing system into a special-purpose computing system customized to facilitate all, or part of, the parking facility resource management techniques disclosed herein. As detailed throughout this description, the program modules **23** may provide various tools or techniques by which the computer **10** may participate within the overall systems or operating environments using the components, logic flows, and/or data structures discussed herein.

The processor **11** may be constructed from any number of transistors or other circuit elements, which may individually or collectively assume any number of states. More specifically, the processor **11** may operate as a state machine or finite-state machine. Such a machine may be transformed to a second machine, or specific machine by loading executable instructions contained within the program modules **23**. These computer-executable instructions may transform the processor **11** by specifying how the processor **11** transitions between states, thereby transforming the transistors or other circuit elements constituting the processor **11** from a first machine to a second machine, wherein the second machine may be specifically configured to support parking facility resource management. The states of either machine may also be transformed by receiving input from one or more user input devices **15**, network interfaces **16**, other peripherals, other interfaces, or one or more users or other actors. Either machine may also transform states, or various physical characteristics of various output devices such as printers, speakers, video displays, or otherwise.

Encoding the program modules **23** may also transform the physical structure of the storage media. The specific transformation of physical structure may depend on various factors, in different implementations of this description. Examples of such factors may include, but are not limited to: the technology used to implement the storage media, whether the storage media are characterized as primary or secondary storage, and the like. For example, if the storage media are implemented as semiconductor-based memory, the program modules **23** may transform the physical state of the semiconductor memory **12** when the software is encoded therein. For example, the software may transform the state of transistors, capacitors, or other discrete circuit elements constituting the semiconductor memory **12**.

As another example, the storage media may be implemented using magnetic or optical technology such as drives **13**. In such implementations, the program modules **23** may transform the physical state of magnetic or optical media, when the software is encoded therein. These transformations may include altering the magnetic characteristics of particular locations within given magnetic media. These transformations may also include altering the physical features or characteristics of particular locations within given optical media, to change the optical characteristics of those locations. It should be appreciated that various other transformations of physical media are possible without departing from the scope and spirit of the present description.

The present disclosure is not to be limited in terms of the particular embodiments described in this application, which are intended as illustrations of various aspects. Many modifications and variations can be made without departing from its spirit and scope, as will be apparent to those skilled in the art. Functionally equivalent methods and apparatuses within the scope of the disclosure, in addition to those enumerated herein, will be apparent to those skilled in the art from the foregoing descriptions. Such modifications and variations are intended to fall within the scope of the appended claims. The present disclosure is to be limited only by the terms of the appended claims, along with the full scope of equivalents to which such claims are entitled. It is to be understood that this disclosure is not limited to particular methods, components, elements, apparatuses, or systems, which can, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting.

With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.).

It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim

recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to embodiments containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g., "a" and/or "an" should be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should be interpreted to mean at least the recited number (e.g., the bare recitation of "two recitations," without other modifiers, means at least two recitations, or two or more recitations).

In instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

In addition, where features or aspects of the disclosure are described in terms of Markush groups, those skilled in the art will recognize that the disclosure is also thereby described in terms of any individual member or subgroup of members of the Markush group.

As will be understood by one skilled in the art, for any and all purposes, such as in terms of providing a written description, all ranges disclosed herein also encompass any and all possible subranges and combinations of subranges thereof. Any listed range can be easily recognized as sufficiently describing and enabling the same range being broken down into at least equal halves, thirds, quarters, fifths, tenths, etc. As a non-limiting example, each range discussed herein can be readily broken down into a lower third, middle third and upper third, etc. As will also be understood by one skilled in the art all language such as "up to," "at least," "greater than," "less than," and the like include the number recited and refer to ranges which can be subsequently broken down into subranges as discussed above. Finally, as will be understood by one skilled in the art, a range includes each individual member. Thus, for example, a group having 1-3 cells refers to groups having 1, 2, or 3 cells. Similarly, a group having 1-5 cells refers to groups having 1, 2, 3, 4, or 5 cells, and so forth.

What is claimed is:

**1**. A non-transitory computer-readable storage medium with instructions stored thereon to manage a parking facility, the instructions comprising:

collecting usage information related to one or more of a traffic pattern, a day of a week, a time of a day, and a usage of parking spaces for the parking facility;

collecting resource information related to electrical resources within the parking facility;

building usage models for the parking facility based on the collected usage information and based on information collected from a Global Positioning System (GPS) unit;

building resource models for the parking facility based on the collected resource information and based on the information collected from GPS unit, wherein the information collected from the GPS unit determines user access demand as a function of one or more of the day of the week, the time of the day, and the traffic pattern;

managing allocation of the parking spaces based on the usage models;

reducing energy expense by a management operation of the electrical resources based on the resource models and the usage models, wherein the management operation of the electrical resources includes a dimming action to dim the parking spaces determined to have little or no activity based on the usage models and an illumination action to increase illumination of the parking spaces reserved by customers based on the usage models to direct the customers to the illuminated parking spaces; and

establishing prices for the parking spaces based on the usage models.

**2**. The non-transitory computer-readable storage medium of claim **1**, wherein the instructions further comprise:

providing an interface to parking customers.

**3**. The non-transitory computer-readable storage medium of claim **2**, wherein the interface to parking customers further comprises an interface for mobile telephones.

**4**. The non-transitory computer-readable storage medium of claim **1**, wherein the instructions further comprise:

providing an interface to neighboring businesses; and

receiving upcoming event information from the neighboring businesses via the interface,

wherein building the usage models for the parking facility based on the collected usage information includes a build action to build the usage models for the parking facility based on the collected usage information and the upcoming event information.

**5**. The non-transitory computer-readable storage medium of claim **1**, wherein the traffic information comprises foot traffic information.

**6**. A parking facility management system comprising: a memory; and

a processor coupled to the memory, the processor configured to:

collect usage information related to one or more of a traffic pattern, a day of a week, a time of a day, and a usage of parking spaces for the parking facility;

collect resource information related to electrical resources within the parking facility;

collect user information related to customers of the parking facility;

identify usage models for the parking facility based on the collected usage information and based on information collected from a Global Positioning System (GPS) unit;

identify resource models to reduce energy expense of the parking facility based on the collected resource information and based on the information collected from the GPS unit, wherein the information collected from the GPS unit determines user access demand as a function of one or more of the day of the week, the time of the day, and the traffic pattern;

identify user profiles for the customers based on the collected user information;

manage allocation of the parking spaces based on the usage models and the user profiles;

reduce energy expense by a management operation of the electrical resources to reduce energy expense based on the resource models and the usage models, wherein the management operation of the electrical resources includes a dimming action to dim the parking spaces determined to have little or no activity based on the usage models and an illumination action to illuminate of the parking spaces that are reserved by customers based on the usage models to direct the customers to the illuminated parking spaces; and

establish prices for the parking spaces based on the usage models.

**7**. The parking facility management system of claim **6**, wherein the processor is further configured to provide an interface to parking customers.

**8**. The parking facility management system of claim **7**, wherein the interface to parking customers includes an interface for mobile telephones.

**9**. The parking facility management system of claim **6**, wherein the processor is further configured to cause increased security to be provided upon request from one of the customers of the parking facility.

**10**. The parking facility management system of claim **9**, wherein to cause increased security to be provided upon request from one of the customers of the parking facility, the processor is further configured to:

initiate additional camera monitoring of parking spaces associated with the one of the customers in response to the request; and

initiate microphone monitoring of the parking spaces associated with the one of the customers in response to the request.

**11**. The parking facility management system of claim **6**, wherein the processor is further configured to:

provide an interlace to an event venue that is independent of the parking facility; and

receive upcoming event information from the event venue via the interface, the upcoming event information specifies a time when an event is held at the event venue,

wherein to identity the usage models for the parking facility based upon the collected usage information, the processor is further configured to identify the usage models for the parking facility based on the collected usage information and the upcoming event information, and wherein the usage models indicate higher demand of the parking facility during the time when the event is held at the event venue.

**12**. The parking facility management system of claim **6**, wherein the processor is further configured to collect traffic information.

**13**. The parking facility management system of claim **6**, wherein the processor is further configured to create user profiles for inclusion into the usage models.

**14**. A method executed by a user input device to manage a parking facility, the method comprising:

collecting usage information related to one or more of a traffic pattern, a day of a week, a time of a day, and a usage of parking spaces for the parking facility;

collecting resource information related to electrical resources within the parking facility, wherein the electrical resources include lighting resources and elevators within the parking facility;

identifying usage models for the parking facility based on the collected usage information and based on information collected from a Global Positioning System (GPS) unit;

identifying resource models for the parking facility based on the collected resource information and based on the information collected from the GPS unit, wherein the information collected from the GPS unit determines user access demand as a function of one or more of the day of the week, the time of the day, and the traffic pattern;

reducing energy expense by managing operation of the electrical resources based on the resource models and the usage models, wherein managing operation of the electrical resources includes a dimming action to dim the parking spaces having little or no activity according to the usage models and an illumination action to illuminate the parking spaces that are reserved by customers according to the usage models for directing the customers to the illuminated parking spaces; and

establishing prices for the parking spaces based on the usage models and the resource models.

**15**. The method of claim **14**, further comprising:

managing allocation of the parking spaces within the parking facility based on the resource models.

**16**. The method of claim **14**, further comprising:

providing an interface to parking customers.

**17**. The method of claim **14**, further comprising:

providing an interlace to neighboring businesses that are neighboring the parking facility and independent from the parking facility; and

receiving upcoming event information from the neighboring businesses via the interface, wherein the upcoming event information specifies a time when events are held by the neighboring businesses,

wherein identifying the usage models for the parking facility based on the collected usage information includes an identification action to identify the usage models for the parking facility based on the collected usage information and the upcoming event information, and wherein the usage models indicate higher demand of the parking facility during the time when the events are held by the neighboring businesses.

**18**. The method of claim **14**, further comprising:

collecting traffic information for inclusion into the resource models.

**19**. The method of claim **14**, further comprising:

creating user profiles for inclusion into the resource models.

**20**. The method of claim **14**, wherein reducing energy expense by managing operation of the electrical resources based on the resource models and the usage models includes:

enabling and disabling operation of the elevators to reduce energy utilization based on the usage models.

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